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For Industry
and Commerce

# SAVING MONEY THROUGH EFFICIENT PEOPLE MOVING 8

Energy, Mines and Resources Canada
Energie, Mines et Ressources Canada

Office of Energy Conservation
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E1-77-15
© Minister of Supply and Services Canada 1980
Cat. No.: M91-2/8-1980E
ISBN 0-662-11154-0

Published under the authority of
Minister of Energy, Mines and Resources,
Government of Canada

SAVING MONEY THROUGH EFFICIENT PEOPLE MOVING 8

# Saving money through Efficient People Moving

## Introduction:

In Canada, 75% of Canadian commuters travel to work in automobiles and the average occupancy of these vehicles is 1.4 persons/car. While improving existing public transit systems, and initiating new systems to communities presently without any service is the most obvious alternative to improve work trip load factors, the potential of this alternative is limited. Due to physical and financial constraints public transit cannot be expected to provide a good level of service for all. However, if employers with an enlightened view of energy conservation and employee relations are willing to make the organizational effort to get things started, carpools and vanpools can become an attractive alternative for those who presently commute in low occupancy automobiles.

This booklet deals in some depths with the basics of establishing company encouraged or sponsored vehicle pools and pinpoints direct and indirect benefits for both the employees and the employer. The following is a brief outline of the procedures for organizing carpools and vanpools, incentive and disincentive suggestions, legalities and employer and employee benefits.

## Moving people efficiently

The day of the lone driver cruising down the highway on his way to work is coming to an end. The high price of gasoline, the rising value of land used for parking, increasing rush hour traffic congestion and the prohibitive costs of constructing new highways are realities Canadian commuters—and Canadian employers—must begin to face.

More and more people are realizing that individually driven automobiles are energy inefficient, and are wasting precious and finite sources of hydrocarbons which future generations of Canadians will need for other purposes.

The most obvious solution is public transit and, where reasonably good service is available, there are many things a company can do to encourage people to take the bus or the subway. For example, some companies in the U.S. provide employees with a $1 per day or more fringe benefit by picking up the transit fare required to get to work. Other companies use "negative" incentives, such as raising parking lot fees so that driving is even less economical.

If public transit to the plant is inadequate, some companies use another tactic — approaching transit officials to get better service. All-day bus service is not always necessary — sometimes buses at shift change are all that are needed. Companies located downtown may want to encourage transit authorities to put more buses on the main route to the plant, or to provide special bus lanes on congested streets.

But, due to physical and financial constraints there are many work locations which cannot be served well by public transit. Work sites on the periphery of a large metropolitan area, industrial parks, and small town factories frequently fall into this category. And one alternative to the low occupancy auto is shared driving — forming a carpool or a vanpool to travel to work.

Almost everyone is familiar with the carpool, in which a group of employees take turns driving their own cars to work, or in which one person drives and others reimburse him.

Essentially, a vanpool works in the following fashion. An employer, group of employees or citizens purchase a passenger van to transport employees to and from work. Participants pay a subscription rate to cover expenses — amortization, operating costs, maintenance, etc. The driver, an employee of the company, is not usually paid for driving the van but is compensated in other ways — by getting a free ride or reduced fare, or using the van during off-hours. The vans carry from eight to fifteen riders, are larger than station wagons, and smaller than buses.

A successful ride sharing service must be acceptable to people in terms of convenience, cost and door-to-door travel time. And its acceptance requires more than public relations

work — it constitutes a major change in people's habits. An organized effort is needed to co-ordinate programs, to provide effective incentives to participants and to maintain the system once it is put into operation.

Companies can do many things to encourage ride sharing. They can set up a carpool or vanpool program themselves. They can provide incentives to people who form their own ride pools. Or, they can help by publicizing the merits of ride sharing. All of these alternatives are covered on the following pages.

Joint travel in carpools or vanpools provides direct benefits to the employer — cost savings on parking space, improved employee availability and attendance, enhanced morale and good public relations for the company. And these benefits increase proportionately with the numbers of people involved.

Whatever the arrangement, companies should offer encouragement for employees to travel to work together. Experience has shown that without direct encouragement from the employer, only those to whom carpooling or vanpooling is an easy and necessary option will become involved.

**Ride sharing options**

Simply stated, there are four pool concepts:

- Carpools in which the passengers know each other. Driving can be rotated among the members and no fee charged; or one member can drive every day and the others pay him a fee.
- Carpooling with manual or computer matching. Passengers are matched up according to housing locations. Either of the driving systems mentioned above can be used.
- Carpooling with designated stops at the roadside. Here, pasengers board the cars at these stops and pay a pre-arranged fee.
- Vanpooling. Instead of cars, vans seating eight to fifteen people are used. This concept is feasible if a sufficiently large number of potential vanpoolers live in one district. Vans may be owned by the users or supplied by the company.

Private carpooling is the concept most widely practiced in Canada. The City of Vancouver and the federal government are experimenting in Ottawa with computerized carpooling. The federal program has been quite successful. The initial project was limited to four departments or 8,000 people, and the government has been pleased with the results. The Vancouver program has not been as successful.

Vanpooling has been used successfully by Polysar employees in Sarnia for years. This program involves fifteen vanpools with up to thirty people in each. These people work three different shifts and share in the costs of purchasing and operating a passenger van to commute to work. And Chrysler Canada's Windsor vanpool program, which started early in 1977, involves 12 vans and 118 people. Response has been favorable and Chrysler hopes to expand the program soon. Using the premise that each van takes six or seven cars off the road every day, the company estimates savings of 11,560 gallons of gas or $9,710 in the first three months of operation.

Car and vanpooling are much more widespread in the United States. Washington's National Aeronautics and Space Administration began a carpooling program in 1965 which has increased car occupancy to an average of 3.85 persons per car — compared to the Canadian average of 1.4 persons. In St. Louis, the McDonnel Douglas Corporation promoted carpooling for its 47,000 employees when parking became critical, and doubled car occupancy among workers. At 3M Company headquarters in St. Paul, Minnesota, the company owns the vans used by the employees. The initial six-vehicle demonstration program has been expanded to include 92 vans.

On the surface, vanpooling appears to be an alternative to carpooling, but in practice, vanpools often supplement and do not discourage the growth of carpools. For example, at the 3M Company, 14.3% of the employees engaged in carpooling as early as 1970, but now, in addition to the vanpooling program, over 20% of the employees are using carpools.

One of the most advanced U.S. programs, in Knoxville, Tennessee, sponsored by the Tennessee Valley Authority, includes express buses, carpooling and vanpooling.

## How everyone profits from pooling

Carpooling and vanpooling benefit both the company and employees. The company wins in a number of important ways:

- Cost savings on parking spaces. Statistics show that 85% of employer-provided parking space is free for the employee. Based on suburban, ground level parking, construction of one parking space may cost a firm $400 to $600, while maintenance, snow removal and taxes cost an additional $20 per year. Costs for high-rise downtown parking can be much higher. Carpools and vanpools decrease the need for parking space and free valuable land that could be better used for expanding industrial or office space.
- Reduced congestion. In most large companies, a great deal of time is wasted in parking lot tie-ups. Car and vanpools can help ease the strain on commuters and make them more productive after arriving at work and before leaving at the end of a shift.
- Employee availability. Ride sharing has been a traditional form of transportation for employees who drive great distances to and from work. It can be a way to tap an otherwise unavailable work force. Polysar Ltd. cites this as a main reason for the Sarnia program's existence. Some of the vans running at the 3M Company program in St. Paul, Minnesota serve low income areas where there is no adequate transit system, and commuting by car is financially prohibitive.
- Improved employee attendance. Car and vanpooling can have indirect benefits in the form of employee attendance. Peer pressure often makes lateness practically nonexistant. And on bad weather days during severe winter months, the same peer pressure will encourage employees to show up rather than stay home.
- Enhanced morale. Car and vanpoolers who don't have to drive, arrive at their jobs more relaxed and prepared for work. A company car or vanpooling program also fosters greater company loyalty, and frequently sets the company in the public spotlight as one which is making a positive effort toward solving energy problems. Better employer-employee relations can also result. As an example, the 3M Company has a vice-president riding with clerical staff in the same vanpool — a situation that provides an ideal opportunity to break down the traditional lack of communication between the two groups.

And the benefits are not limited to company management. Among the "pluses" for employees are:

- Fuel savings. Gas costs over a dollar a gallon in many parts of Canada, and more price rises are coming. As costs continue to rise, fuel savings are increasingly important.
- Monetary savings. Vehicle operating costs are cut in half when two people share a car, and if four people are in one pool, each spends only a quarter of the operating costs a lone driver would incur. Parking fees, if applicable, are also cut.
- Reduction of road congestion. The present operating occupancy of a private commuter vehicle in Canada is 1.4 persons per car. If this occupancy could be raised to 3.0, the number of vehicles would drop by half. Imagine the difference this would make on Toronto's Don Valley Parkway, Ottawa's Queensway or Montreal's Decarie Expressway!
- A car at home. Car and vanpooling allow other members of the commuter's household to use the car during non-use periods. Days when the commuter rides with another driver, other family members can make daytime trips for shopping, appointments or social events. In some cases, the need for a second car can be eliminated.
- Improvement of the environment. As fewer cars travel on less congested roads, air pollution is reduced. Stop and go traffic, caused by people driving to and from work during rush hours, is the worst offender in terms of pollution.
- Comparable travel time. Only pick up time is added to the trip, and this is negligible where people live in the same area or along the main route to work. In addition, many carpools and vanpools are given priority parking, and time can be saved in walking from the parking lot to the work area.

# How much can I expect to save?

The answer is that it really depends on the number of persons in your pool. If, for example, you previously drove alone and there are now four others in your pool you may save as much as 80% on gas or parking fees from your previous commuting costs. The type of car you drive must also be considered when calculating the actual saving. And you should also consider savings on the wear-and-tear items such as tires, batteries, brakes and filters. It all adds up to a substantial saving over your normal operating expenses. And think how nice it would be not to have to drive every day. The tables below and on the right provide a breakdown of the national average costs of operating certain types of cars. They will provide some guidance to how much it really costs you to run your car.

# A guide to car operating costs

The question of how much it costs you to operate your car is very difficult to answer. Personal records provide the only really accurate means of calculating the cost. However, the following figures derived from the Canadian Automobile Association publication "Car Costs 1976" will provide a helpful guide.

# Costs per mile

Standard size domestic car with automatic transmission:

| Fixed Cost | Variable Cost | Total |
|---|---|---|
| 15.5 cents | 8.3 cents | =23.8 cents |

Sub-compact with standard transmission:

| Fixed Cost | Variable Cost | Total |
|---|---|---|
| 9.4 cents | 5.3 cents | =14.7 cents |

**Fixed Costs** include fire and theft, collision, property damage and liability insurance; license and registration and average annual depreciation costs.

**Variable Costs** include such items as gasoline and oil, maintenance costs and tires.

# Car insurance

Although I.C.B.C. states that you are not legally required to carry insurance beyond the applicable minimum, it is strongly recommended that you obtain not less than $500,000 third-party liability coverage. For your own security, please check with your insurance agent before carpooling.

## YOU SAVE WHEN YOU CARPOOL

Here's an example of what it costs annually for a 20 mile daily round trip to downtown Vancouver if you drive a standard size car with automatic transmission:

| | | |
|---|---|---|
| 1. Multiply (23.8 cents) (cost per mile) × (20) (miles per day) | = $ | 4.76 |
| 2. Add daily parking cost | + $ | 2.25* |
| | $ | 7.01 |
| 3. Multiply by number of working days per year | × | 240 |
| 4. Equals cost per year to drive alone | = $ | 1682.40 |

**typical Vancouver all day parking rate.*

Calculate what it costs *you* to drive your own car to work each day:

| | | |
|---|---|---|
| 1. Multiply *( ) (your cost per mile) × ( ) (your round trip mileage) | = $ | |
| 2. Add daily parking cost | + $ | |
| 3. Multiply by number of working days per year | = $<br>× | 240 |
| 4. Equals your cost per year to drive alone | = $ | |

**insert 23.8 cents for standard size; 14.7 cents for sub-compact; or the actual per mile costs for operating your own car.*

Here's what you could save on the *variable costs* alone:

| | | |
|---|---|---|
| 1. Multiply *( ) (your variable cost per mile) × ( ) (your round trip mileage) | = $ | |
| 2. Add daily parking cost | + $ | |
| 3. Total variable cost | = $ | |
| 4. Divide by the number of people in the carpool | + | |
| 5. Equals the cost to you if you carpool | = $ | |
| 6. Your minimum daily saving is the difference between 3 and 5 | = $<br>× | 240 |
| 7. Minimum annual saving | = $ | |

**insert 8.3 cents for standard size; 5.3 cents for sub-compact; or the actual variable costs for operating your own car*

Remember that by pooling you might completely eliminate the need for a second car, saving you perhaps an extra $1,000 (depending, of course, on the car). Consider these savings. Ease the squeeze—it pays to pool!

The advantages of ride sharing are numerous, from everyone's point of view. Once the company has decided to promote ride sharing, it has a number of options — carpooling, vanpooling or provision of incentives for employees.

## Carpooling

Everyone is familiar with the carpooling concept. And many people have even participated in carpools at one time or another — when one father drives all the boys to scouts; when friends agree to ride together to the club every Wednesday night; or, as we're suggesting, when a group of people go to work in the same car.

The simplest carpools are those in which all the passengers know each other and where arrangements can be made among the passengers themselves. In some cases, the driving is rotated among the carpoolers and no payments are made. In other cases, the driver is the same person each day, and the passengers pay the driver. Combinations of the two systems are also possible. When the passenger-run carpool is encouraged, the company's role is limited to providing incentives to participants.

The alternative — "dynamic" carpooling — requires more effort and organization on the part of the company. Here, the employer matches potential carpoolers, manually or using a computer. As for the actual driving, either of the two systems mentioned above can be used. Another alternative is designated stops at the roadside, where passengers board the car and pay a pre-arranged fee.

# Make ride-sharing fun for everyone.

Follow these ten simple rules for carefree car pooling.
We made them simple so that we could understand them.

1. **Think about others.**
*Like marriage, staying together is far more difficult than simply getting together in the first place. Be honest with one another. Some poolers are great conversationalists, others are duller. Seek the middle ground. Don't hog the heater or the chatter. If you enjoy a good Havana join a smoking club, if you want to share a ride, be considerate of your pooling partners.*

2. **Get organized.**
*Know what to do if someone breaks a leg or finds some other feeble excuse for not going to work. After calling a doctor, remind George that he is the reserve driver. Decide beforehand who to call if arrangements have to be changed.*

3. **Sharing the costs.**
*Decide on the cost sharing arrangement when you have your first get-together. Use the example in the folder to calculate your share of the cost. Then fix a pay-day and stick to it.*

4. **Who drives?**
*In some pools, the same person drives almost continuously. Trust her. She likes driving (as a child, she made brr-mm, brr-mm noises). Other pools prefer to alternate drivers, with each person taking a turn. Do what suits you best but establish the driving schedule well in advance.*

5. **Where to meet?**
*Big Julie's is a good spot, but the parking lot is the usual meeting place for the drive home. In the mornings, try to keep the number of stops down by choosing pick-up points convenient for more than one passenger.*

6. **Decide your route and timetable.**
*Find a good route and stick to it. The CP right-of-way along East Boulevard is not recommended. It's too bumpy. If someone fails to show up, certainly wait for a minute or two, but keep in mind that a long wait may make three people late instead of only one.*

7. **If you have a 'dropout'.**
*Don't panic. We have a sister who is one and it isn't contagious. Keep in mind that Commuter Club is willing and able to find a new member for your pool. Contact your Commuter Club Coordinator or Commuter Club Headquarters for assistance.*

8. **Good housekeeping.**
*The occasional vacuuming may turn up a dollar or so in change. Don't tell anyone. Use it for a car wash. And, apart from a weekly clean-up, make sure that the car safety items are regularly inspected.*

9. **Straight home; no side trips.**
*Errand running and carpools mix like prunes and gravy. Shopping trips should be confined to more suitable times.*

10. **Drive safely.**
*Seriously...*

From Vancouver Commuter Club brochure

Dynamic carpooling has several advantages over the basic system. Even if the idea of carpooling occurs to a commuter, it can often be difficult to establish an acceptable carpool among associates due to distances between residences. By enlarging the universe of potential matches to include more employees, the carpool information gathered under the dynamic system can bring together more commuters with similar travel needs.

**Implementing a program**

Once a company has decided to start a carpool program, it should appoint a group of people or committee to head the implementation of the project. This group should be a combination of middle and upper management and employees. Ideally, the people in the group should have a personal interest in energy saving, air pollution and traffic congestion, since their enthusiasm is bound to rub off on others. This group's job is to motivate company employees — through coffee klatches, circulars, bulletin board board advertisements, etc. If in-house publications such as newsletters, trade or union papers are available, they can also be used effectively to publicize carpooling.

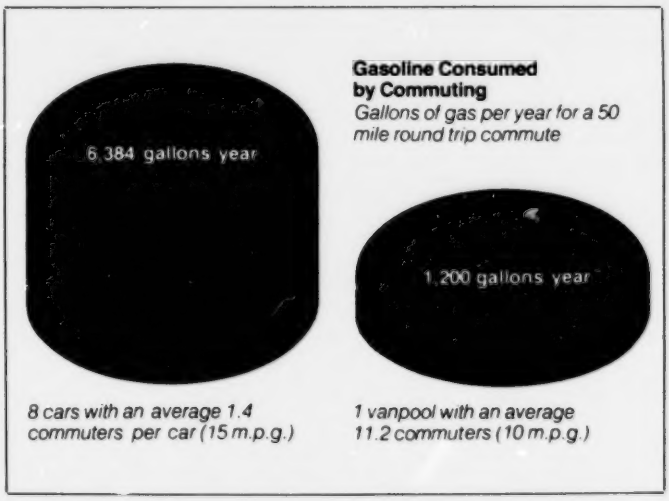
Much of the program's success depends on initial publicity. Potential carpoolers must be made aware of the advantages and details of the program. If the budget permits, brochures, pamphlets, posts or stickers can be used to achieve this initial impact.

The City of Vancouver's carpooling program, for example, involves a pamphlet called "Car Pooling, What's In It For You?" It describes how to save money by joining the "Commuter Club", how to join, and provides an application form. The brochure even includes a section on carpooling etiquette.

The Ontario government has published a booklet called "Car Pooling Makes $ense" for its program. The federal Office of Energy Conservation provides a brochure as well as a poster with the caption "Save Cash and Fuel in a Pool".

Another key to an effective carpool program is use of incentives (see section on incentives for details). Many incentives are doubly effective when combined with a company-sponsored or "dynamic" carpool program — priority parking spaces, free parking, provision of vehicles for carpoolers, automobile operating cost incentives, gasoline tax rebates and working hour incentives. Disincentives to the low-occupancy auto, such as higher parking charges, can also be used effectively.

Another kind of "perk" can be provided when passengers do not know each other — to help overcome the change-of-habit problem and to reach the person who is relucant to drive to work with a bunch of total strangers. For example, matchmaking schemes often try to match non-smokers as an inducement to relieve the anxiety of those who do not like to ride in a crowded vehicle with smokers. Face-to-face meetings can be arranged on company time for potential carpoolers to get acquainted, and employers or sponsors should assure potential carpoolers of the safe driving habits and records of the participants.




**Matching carpoolers**

The mechanics of setting up a carpool involve four stages: promotion collecting information, matching people involved, and distributing information regarding suggested pool combinations.

Each employee should receive an application form with a covering letter, brochure or booklet explaining the program. Meetings can be held to clarify any questions. And every employee's response should be sought with the understanding that the application does not commit him to participation. Often, if returns are made through employee supervisors, the

response is greater than if they were just mailed in to a committee. With a higher percentage of returns, a greater number of acceptable matches is possible. And many programs carried out in this way have obtained a 90% employee response.

The data needed depends on the extent of the program. Where the program serves one major parking and employment area, the essential data may be limited to name, home address and business telephone number. Time of arrival and departure are included where shifts or staggered starting times exist. Additional questions may be included such as the person's desire to drive only, ride only, or share driving; and his preference of smoking or non-smoking companions. Information concerning present mode of travel to work can be solicited as well. However, an easy-to-understand, short data form will get the best response.

Data can be matched manually or by computer. Generally, where there are fewer than 300 potential applicants, a hand matching or manual technique is easy and inexpensive. Application forms are given different numbers, and these numbers are plotted on an area-wide map. Visual inspection will suggest acceptable carpools based on location of applicants. However, other variables such as working hours, driver only / passenger only preference and non smoking / smoking preference can also be considered.

The computerized approach to carpool matching is usually based on either a grid system, census tracts or traffic analysis zones. The home and work locations of participants can be input into the program by manual identification from grid maps or through automatic address coding. A computerized program based on a dual density grid system such as the Canadian Burroughs or Postal Code system or the one developed by the U.S. Federal

## APPLICATION

Please complete this questionnaire, even if you are not sure that you want to join a car-pool at this time.

1. [A] (1) **Name** [ ] (3) — Fill in number — 1 = Mr. 2 = Mrs. 3 = Miss 4 = Ms. — Last Name (18) — Initials (19 20)

2. **Address** [ ] (21) Number Street — City (50)

(51) Nearest Street Intersection (65) [ ] (66) Postal Code (71) [ ] (72 75) [ ] (76 79)

3. [B] (1) **Work address** [ ] (2) Office Address Section Room No. (18) (19) Department (25)

4. **Telephone**

(26) Work – (32) (33) Local (36)

OR

(37) Home – (43)

5. **Smoker — Non-Smoker Preference** — Fill in number (45) 1 = non-smoker 2 = smoker

6. **Drive/Ride Preference** — Fill in number (46) 1 = drive only 2 = ride only 3 = share driving

[ ] (69 73) [ ] (74 78) [ ] (79 80)

7. **Work hours**
I work from: : (47) (51)
to: : (53) (57)

**Example:** from: 0 8 : 3 0 A M
to: 0 4 : 3 0 P M

8. **How do you get to work?** [ ] (63) — Fill in number 1 = drive alone 2 = drive with others or passenger (car-pool) 3 = bus 4 = other

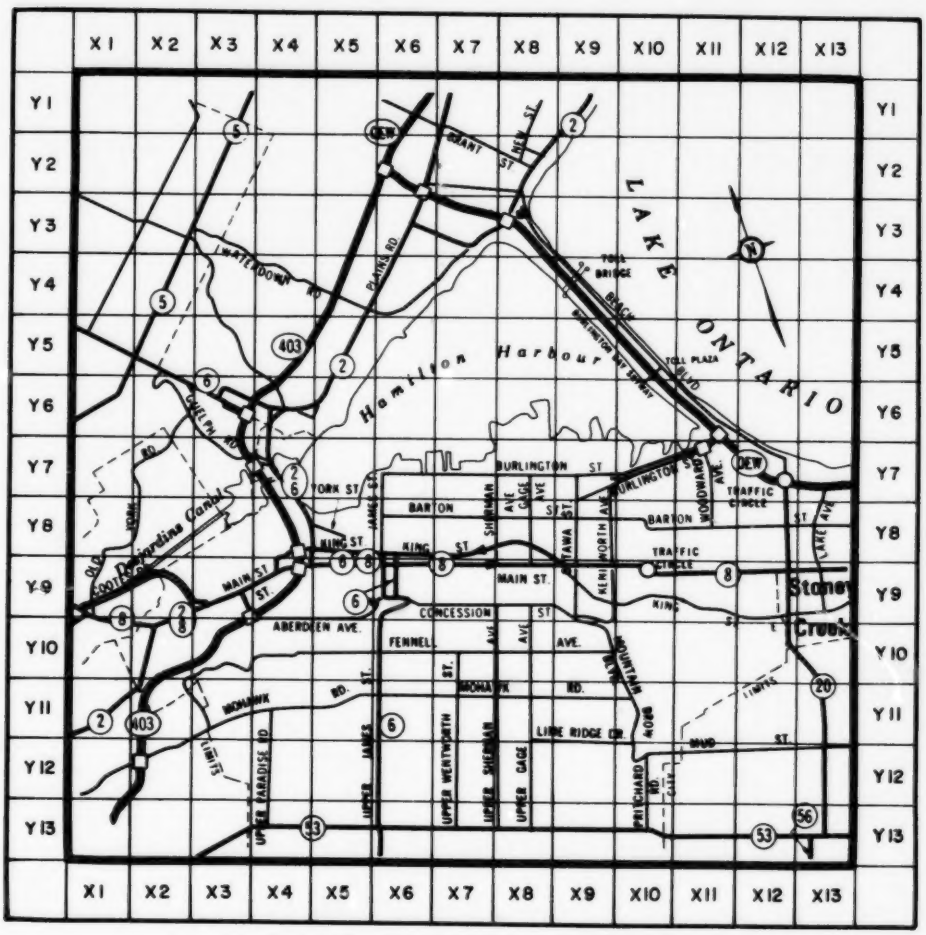
**If you pool, how many others are in your pool?** [ ] (64)

9. **In which language would you prefer to receive correspondence?** [ ] (65) — Fill in number 1 = French 2 = English

Highway Administration, provides a comprehensive approach to carpool and buspool matching. This type of program can handle multiple work locations and multiple work times simultaneously, but separately. A federal government computer program will soon be available to any employer requesting it.

A critical variable in any matching system is the correct size of land area for grouping suggested pools. Total door-to-door travel time is significant, and generally when the total travel time for all ride sharers falls within a 25 percent increase over the fastest alternative, it constitutes an acceptable pool. Experience also indicates that one-square-mile areas are acceptable for gathering carpools in higher density regions, while areas ranging to four or more square miles are acceptable in less dense regions.

Distance from the employment source should also be considered. Operational experience in the U.S. has shown that a high percentage of those who travel long distances (greater than 10 miles one way) to work who don't have public transit available to them would join a pool if the opportunity arose. And a U.S. study concludes that 20% of those who commute 10 to 15 miles (one way) and 25% of those who commute 15 to 20 miles would choose to be car or vanpool participants if given the chance. When driving time is more than 45 minutes, commuters may accept driving to a specific residence or pre-determined parking area where carpools originate. The potential combinations are many, and any reasonable grouping should be suggested, allowing the individual to make the final selection.




**GRID MAP FOR CARPOOL MATCHING**

**Example: If you lived in Stoney Creek at the junction of Highways Nº 8 and 20 your grid would be X12 - Y9.**

After potential matches are selected, distribution of information may be handled in several ways including personal contact, mail and master lists. However, personal contact is usually the most successful method. One way is to bring together 50 to 100 of the potential carpool members for a "coffee hour", an extended regular coffee break in which people discuss special arrangements for forming new carpools. The informal session could start with a "pep talk" on the carpool program, followed by questions. Carpool listings could be distributed before or during the meeting and a master list maintained at selected points for further reference.

Mailing or internal routing systems can be used along with the personal contact method, or where the personal contact method is not feasible.

In some cases where employees are constantly working on different shifts, the matchmaking process must be far more flexible, since employee combinations will differ from week to week. One way of solving this problem is use of a pegboard. The Sarnia vanpool operation uses this method. Each member of the pool has a plastic disc with his name, address and telephone number on it. The disc has a hole in the middle and fits over a peg. A pegboard is set up as a matrix of eight columns and three rows, and commuters place their pegs in the columns to indicate when they are coming in. The driver for that shift sorts out the discs on the section of the pegboard pertaining to that particular trip, puts them in order of pickup and thus determines the route.

In the Chrysler of Canada program the problem of vanpoolers working on different shifts is solved by grouping all the people who work straight days into a few vans, and by ensuring that the people in the other vans are given the same shifts at the same time.

**Maintaining the program**

Once the carpool program has begun, it is important to maintain or increase the occupancy rates derived from the initial matching effort. One way to make sure people are happy with the program is to send around a questionnaire to participants to get indications about deficiencies in the program and how to attract new participants.

Vacancies will still exist in some carpools and others will develop quickly due to people moving or changing jobs. A final phase in a comprehensive carpool program is provision of readily available master lists which are periodically updated. To be effective, the availability of this service must be made known to all employees.

The frequency required for updating information depends on factors such as rate of employee turnover and number of employees involved. Existing personnel records and parking permit applications can be helpful in the updating process. It may be possible to have new employees indicate their willingness to participate in the program by having them fill out matching forms at the time of personnel processing. Arrangements to obtain changes in employee addresses and phone numbers should be explored.

As new applications are received, all names can be compared and corrections made as well as including new names. Or, in the case of computer matching, when a sufficient number of changes are obtained from these sources, the computer card deck can be updated and the entire program run again to produce a new master listing.

Where access to existing data is difficult, a periodic resurveying of all employees can be used to maintain an up-to-date list. While this approach requires more effort, it provides an opportunity to show management's continuing support of the program. It also provides a chance to refine the surveying process on the basis of experience gained the first time around.

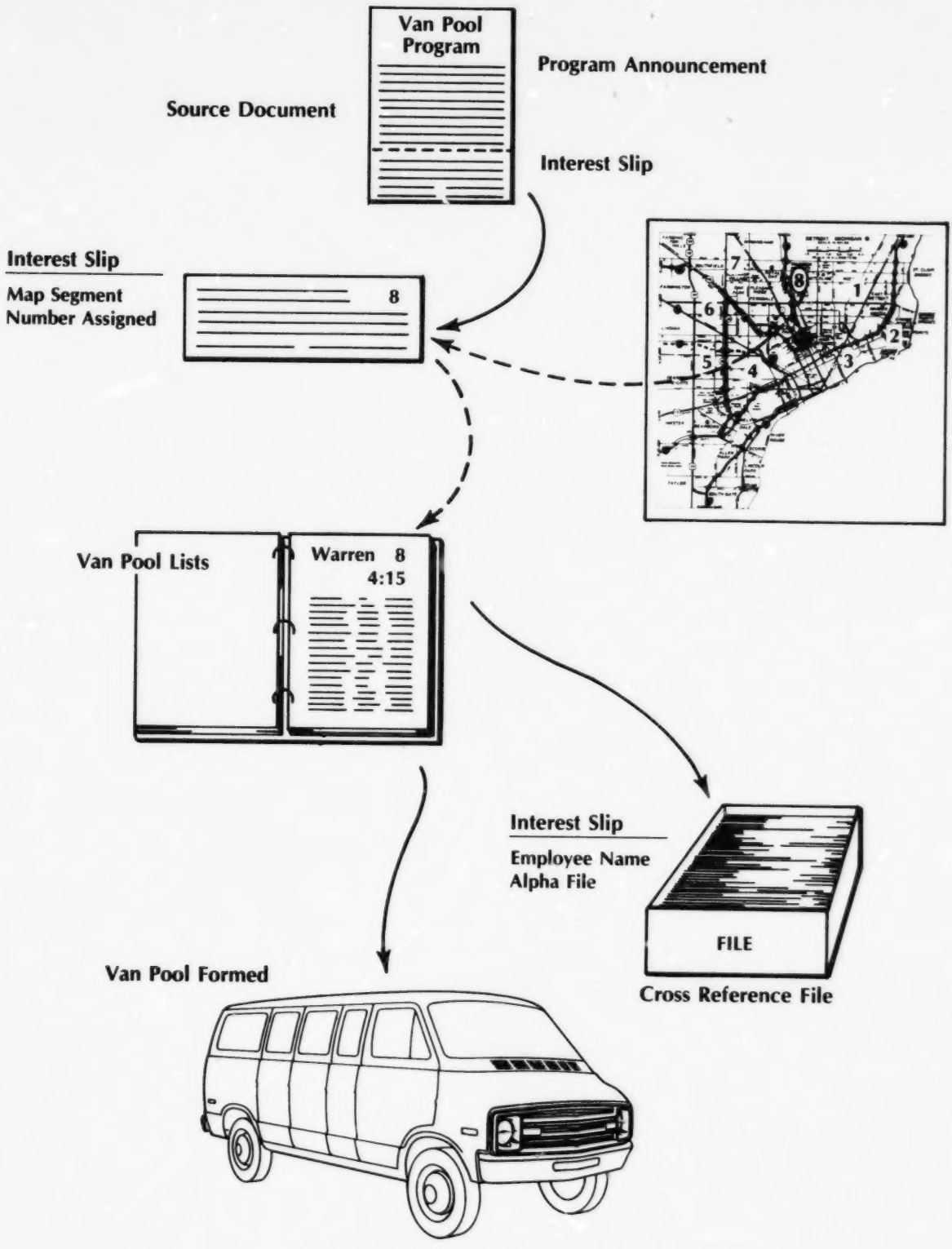
## Vanpooling

Since each van takes more cars off the road, vanpooling is even more efficient than carpooling in reducing energy use, traffic congestion and air pollution.

An obvious advantage of vanpooling over carpooling is that employees do not have to use their own cars for driving to and from work. At the same time, vanpooling retains the convenience of door-to-door pickup and offers some of the virtues of a bus — including a regular driver and more freedom for the passenger to choose where to sit and how to use his travel time.

Vanpools can be used to take employees from

## Flow Chart,
## Manual Matching Method



outlying areas into the city. But they are equally suitable for use in industrial parks and periphery areas which are not well served by bus service. **One established criterion is that vanpools are most feasible when the route length is greater than 8-10 miles each way.**

In practice, the company has several options as to the degree of its involvement in a vanpool program. Certainly, it can administer the whole program — taking responsibility for purchase of vans, insurance, publicity, etc.

And if the company purchases the van, the purchase price is merely a loan since it will be recovered through employee fares. And an additional stimulus for vanpooling may be provided in the near future if the federal government decides to institute guaranteed loans for van purchases.

However, the company may feel it is preferable to have the vans owned and insured by individual employees, existing employee associations (e.g. credit unions) or commuter clubs formed for this purpose. This makes it possible for the firm to initiate a vanpool program without direct financial involvement in its operation. Employee ownership also may reduce the company's risk exposure. At the same time, some statement of company backing may help employees obtain more favourable finance or leasing charges.

For example, the Polysar Employees Credit Union in Sarnia, Ontario helps each of its members commuter associations purchase vans and provides central accounting services. Operations are handled individually by each van's association.

The company should decide at the outset which steps it wants to initiate and which should be left to the van owners. It might decide, for example, that a company vanpool administrator could best provide the survey and promotional services in the program's early stages and can suggest guidelines for driver and rider selection. The rest can often be left to each individual pool.

Whether a community association is formed, or whether the company purchases the van, a few members are designated as driver / co-ordinators. The members of the vanpool pay to ride — usually on a per month basis — and the fee is set to cover purchasing expenses and costs of running and maintaining the van. Drivers do not pay to ride.

Fares may be collected by the driver, deducted from the payroll or billed to the passengers. In addition, the driver may be allowed additional benefits: to keep fares collected after the breakeven points have been reached (most companies calculate breakeven point as involving eight to ten passengers for a 12 passenger van); to use the van on weekends, paying a fee to the company based on mileage used; or to have an option to buy the van when it is retired from the fleet.

Some firms even lower van fares by using their vans for business or as inter-plant shuttles during the work day. In turn, the department using the van pays the van account a mileage rate.

**Organizing a vanpool program**

Most firms start their vanpool programs with a few pilot vans in order to test out their operating policies and employee acceptance. In almost every case, the programs have been enthusiastically received, as shown by waiting lists and groups that form for new vans. Existing evidence shows that if management backs vanpooling, employees will participate. In addition, once an employee starts vanpooling, he or she is likely to stay with it — the major problem is overcoming the initial apprehension.

Before plunging into a vanpool program, the company may want to determine the demand for such a service. A sample demand survey form is included.

One of the misconceptions about vanpooling is that it involves hefty administrative duties. In fact, the best way to run a vanpooling program is by using as little paperwork as possible. Once the program is running, it should take very little administrative time. For example, the huge 92-van 3M program in the United States requires the time of one and a half people.

Naturally, the first step in implementing a vanpool program is to appoint someone to manage it. Vanpool programs are typically administered by people from the transportation, personnel or administrative services departments. And once the vanpool program administrator has been appointed, he should confer with all the appropriate staff organizations — legal, accounting, personnel, insurance, etc. — to obtain agreement on the details of administering the vanpool program.

## Commuter Van Pool Interest Survey

I am interested in becoming a member of a Commuter Van Pool.
I would like to be a

☐ Driver ☐ Passenger ☐ Either

Name _____

Address _____ City _____

Nearest major cross streets _____

CIMS _____ Office Phone No. _____ Start Work _____ Leave Work _____

**MAIL TO: Mr. Tom McDonald CIMS: 416-15-22**

Decisions must be made as to buying or leasing of vehicles. Some employers prefer to purchase their vans because of the total control this arrangement offers in terms of internal cost management. Purchasing may offer a great opportunity for company support of specific cost items. A lease cost automatically includes items such as excise and sales taxes, finance charges and the lessor's own business expenses

A method of establishing rates must also be determined along with a way to collect fares. The driver can collect the fares, or payroll deductions can be used. If payroll deduction is chosen, appropriate forms and a method of processing are required. An alternative is having the driver bill each passenger at the beginning of every month. The passenger then pays the required amount to the cashier. This last alternative has merit since it relieves the driver of the responsibility and potential problems of collecting and handling money.

The following specifications are suggested as requirements for vans:

- 12-15 passenger van
- 300-360 cubic inch engine
- front and rear heating
- 3-speed automatic transmission
- power steering and power brakes
- 8.75 x 16.5, 8-ply tires or equivalent
- outside low mount mirrors

In addition, all vans should be equipped in accordance with provincial safety regulations.

As with carpooling, publicity for a vanpool program is very important. Program announcements should be prepared and circulated, along with a reply form to be sent through employee supervisors indicating interest in becoming a rider or driver-co-ordinator, (see carpool section for ideas).

One of the best ways to publicize the program is to offer incentives. Several companies in the U.S. offer free demonstration ride periods. Such an incentive can be the key element in starting a program since studies show that once an employee starts vanpooling, he will stay with it. Another good way to publicize the program is to park a sample van in front of the building with a sign stating the advantage of vanpooling.

## Van Pool Lists

### WARREN

**#8**
**4:15**

| Name | Office Ph. | Major Cross Streets |
|---|---|---|
| S. J. JONES | 6-5142 | Garfield & 13 Mile Rd. |
| T. M. THOMAS | 6-3728 | Moran & 13 Mile Rd. |
| B. L. ALLEY | 6-2061 | Kelly & 12 Mile Rd. |
| V. O. AKERS | 6-2742 | Sims & Kerby |

Other incentives, (see incentives section) are also applicable.

Interested employees should be grouped into vanpools. Both manual and computer-matching techniques are also applicable here.

Once a list of prospective riders and driver / co-ordinators has been compiled, a meeting should be held with interested employees at which time the proposed program is explained and questions answered.

Prospective driver / co-ordinators should then be contacted and evaluated on the basis of: a safe driving record; a valid driver's license and the willingness to apply for the correct class of license required in the province; a job not normally requiring travel or overtime; a low incidence of absenteeism or tardiness; and a recommendation by his supervisor (optional).

The drivers chosen should be presented with the names of potential vanpoolers from their area of residence to assist them in organizing a vanpool and be given vanpool sign-up forms and payroll deduction forms (if applicable) to be completed by the potential vanpool passengers. Because of the nature of their responsibility, the driver / co-ordinators should sign binding agreements (see page 17).

Driver / co-ordinators should be briefed as to the operator's manual and insurance and accident procedures. Additional safety measures include provision of drivers with St. John Ambulance training, and having two drivers in the van.

The program administrator should arrange for delivery of vehicles to driver / co-ordinators. When the drivers and passengers have been selected for a particular vanpool, the exact daily round trip distance, including passenger pickup and delivery, should be calculated. Commuter fares can then be established.

**Maintaining the vanpool program**

The program administrator's job is not over once the program is set in motion. As in the case of carpools, information on vacancies and new vanpoolers should be maintained (see carpool section).

Vehicles should be inspected periodically for both appearance and operating condition. The maintenance of the vehicle should comply with the instructions in the owner's manual. Periodic meetings should be held with driver / co-ordinators to exchange program information and provide communication between the drivers and the company management.

The program administrator should receive and review monthly each driver / co-ordinator's revenue and expense report. He should check to see that authorized payroll deductions are being processed and that receipt totals balance each month. He should authorize payment of program expenses (lease or purchase payments, insurance, etc.) as the invoices are received, and report vanpooling program status to company management on a monthly basis. In addition, the program administrator should serve as a clearing house for comments, complaints and information on the commuter van program.

There are, of course, no "hard and fast" rules, and the suggested format is just that. Its purpose is merely to provide and guide and show considerations involved in implementing a vanpool program.

**Company incentives**

There are several ways in which a company can encourage car or vanpooling without actually setting up a program. However, the company must be careful that incentives are not looked upon as discriminating against those employees, who through no fault of their own, are not able to participate in either vanpools or carpools. One of the best ways, is to establish priority parking spots for carpools — cutting a few minutes off the commuter's travel time and often saving him a cold walk through an open parking lot. The most common procedure for implementing preferential parking is issuing stickers which are applied in a visible spot on the vehicle, permitting easy identification of unauthorized cars, either at point of entry or during patrols of parking areas.

Enforcement should also include some method for inspecting incoming or outgoing vehicles to be sure that the vehicle is indeed carrying the number of persons specified. This incentive is most successful when employees can perceive a distinct advantage to themselves over their fellow employees who do not carpool, not merely a marginal improvement over an existing parking situation.

Another incentive is free parking. A recent survey of the employees at the King County assessor's office in Seattle, Washington indicated that free parking was nearly twice as effective as other methods in encouraging carpooling. (Conversely, raising the rates for everybody in the parking lot also provides an excellent incentive for carpooling!).

Another possible incentive is provision of vehicles for carpoolers, in cases where the company has a pool of vehicles used to conduct company business. Frequently company vehicles are returned to a garage or lot at the end of the day to remain idle until the next morning. This capital equipment could be more effectively used by allowing employees to drive the vehicles home at night if they form carpools. And such a program is operating at the Arkansas State Highway Department in Little Rock, Arkansas. Here, state vehicles carrying a minimum of three carpool riders are permitted to be taken home at night.

Automobile operating cost incentives, gasoline tax rebates, and working hour incentives are also available to the company looking for incentives. The latter could take the form of slightly reduced working hours or shift rotation preference for carpoolers, provision of flexible working hours, or encouraging the maintenance of normal working hours so that employees will not be subjected to overtime and can meet their carpools. This last method has been used effectively at the Pentagon in Washington, D.C.

Shell Canada Limited came up with an innovative way of encouraging its employees to carpool. During Ontario's Energy Conservation Week, October 31 to November 6, 1976, Shell offered to donate $5.00 to the United Way for each of its employees who returned an enclosed card stating that during that week he engaged in one of the activities listed on the card. One of these activities was carpooling. The program lasted only a week, but on a larger scale with, perhaps, a more modest financial incentive, this type of program could promote carpooling and at the same time provide good public relations for the company.

**Checking the legalities**

Vanpooling and carpooling — against the law? Not as a rule. But be sure to check with municipal authorities and provincial transportation departments before proceeding with a program. Legalities such as insurance requirements or competition with buses and taxis have posed some problems for car and vanpool programs.

But as the ride-sharing concept becomes more widely recognized, many provinces are taking steps or are expected to take steps to change applicable legislation. When the City of Vancouver decided to institute its Commuter Club program, the provincial and municipal authorities acted very quickly to change the legislation regarding car and vanpooling. And the Ontario government is currently investigating the legal issues related to ride-sharing — with a view toward changing legislation.

In the meantime, look into the following areas before you start your program:

- Check with the appropriate authorities. After the intended program has been drawn up, regulatory bodies should be contacted. Sometimes more than one authority is involved, as in large municipalities such as Toronto and Vancouver. Even in some smaller cities, approval must come from provincial departments before traffic and other by-laws can become effective. Cover yourself and your program by contacting both municipal and provincial authorities.
- Drivers licenses. In most carpools, drivers do not require special licenses. However, vanpool drivers responsible for large numbers of people normally need special licenses. Check with the provincial transportation department for details.
- Taxi regulations. In some provinces, carpool vehicles can be classified as taxis depending on the wording of the law. Check with municipal authorities to make sure this is not the case. In Quebec, check with provincial authorities responsible for taxi legislation.
- Exclusive franchise rights of transit systems. The attitudes of transit authorities to car or vanpools vary. In Sarnia, the transit company considers the vanpool associations a complementary service. However, the London, Ontario Transportation Commission prevented a private service from operating between the University of Western Ontario and some of its colleges on the basis of exclusive franchise rights. The Sarnia attitude seems to

be the norm. Nevertheless, it is wise to check with the transit authorities.

- Insurance. In provinces which have no-fault insurance, in the event of an accident, a carpool passenger will be able to claim whether or not the driver of the vehicle was at fault. But problems can arise in other provinces. When payments are made in a carpool, the passengers are not considered "guest passengers" and are not covered by standard insurance. Drivers of carpool vehicles must take out additional insurance to cover their liability to these passengers. Vanpool operators require special insurance as well.

  Because members of a carpool are said to be acting in a joint enterprise, it is often mistakenly suggested that an injured passenger cannot sue the driver. Under the law, this simply is not so. If drivers of carpool vehicles are covered by insurance, it is unlikely that an injured third party would want to sue a passenger in a carpool vehicle. However, if this happens, passengers are not liable for the negligence of the driver.

  One problem could arise if the driver did not have sufficient insurance coverage. The insurance company could then go to other members of the group so that their insurance could cover the accident.

- Employer liability. Employees are generally not covered by the various workmen's compensation schemes when travelling to and from work, even if the transport is provided by the employer. If time spent travelling is included in the terms of employment, compensation coverage generally does apply.

  An employer can be liable to the public for the negligence of another employee under what is called "vicarious liability", but the employer is liable only if the workman was negligent in the course of his employment. Here are three common cases:

1) When the employer hires a bus and provides a driver, he is responsible—since the driver was employed for this purpose.
2) When the employer is covered by workmen's compensation at the time of the accident—since it occurred during working hours.
3) When the carpooling vehicle is owned by the employer, he can sometimes be responsible—since owners of motor vehicles in all provinces are liable for damages caused by that vehicle, and are responsible for ensuring that the vehicle is in good repair.

- Personal liability. When does an employer become so involved in providing carpooling activities that he becomes liable on a personal basis for injuries caused to a participating employee? A decision on personal liability is usually based on whether it was or should have been contemplated that someone would be injured by your actions. Questions then arise as to whether the type of injury was forseeable or too remote. It is difficult to indicate at which point an employer will make himself liable; each situation depends on the facts.

  The employer's involvement in matching schemes could cause a case of personal liability. If the employer matched people with a driver with a bad driving record, for example, he could be held responsible. Another case for personal liability might be if an employer did not properly maintain a vehicle.

It all sounds rather ominous. But it isn't really. A little forethought and a chat with company lawyers and outside agencies generally sort out potential problems in short order. The benefits of carpooling and vanpooling far outweigh the costs of a few hours spent to assure that a program is properly established.

**Ride sharing — good public relations**

No matter which approach a company chooses — encouraging public transit, providing incentives or actively setting up a carpool or vanpool — the results will be positive. As gas prices go up, employees will start looking for ways to economize and will become more responsive to ride sharing. The fact that the company is promoting something that will save gas and money is good public relations.

The response to any of these programs may not be overwhelming at first. But keep at it. With rising gas prices and congested traffic, ride sharing is the trend of the future. Why not get in on the ground floor?

**APPENDIX I**

## Chrysler Commuter Van Program Operating Agreement

This Agreement between the Driver/Coordinator whose signature appears below and Chrysler Corporation (hereinafter called "Chrysler") shall become effective on the date it is accepted by Chrysler, as evidenced by the signature of its authorized representative in the space provided below for this purpose.

For the purpose of forming and operating a van pool with a minimum of nine (9) passengers, Chrysler agrees to furnish the use of a 12-passenger van, to assist in forming and maintaining the van pool and to render such other reasonable assistance as may be required for the functioning of the van pool. The Driver/Coordinator will be the primary driver of the van during the term of this Agreement.

The Driver/Coordinator agrees to be responsible for the following in connection with the operation of the van assigned to him:

1. Maintain a valid state driver's license (and/or chauffeurs' license, if required) for operating a van.

2. Drive the van to and from his Chrysler location and pick up and deliver the other Chrysler employees who pay to ride with him.

3. Keep the passenger pool for the van at or above the minimum of nine (9) paying passengers.

4. Arrange for service and fuel for the van and clean the vehicle inside and out as needed.

5. Train a back-up driver to insure daily operation of the van.

6. Supply a secure place for "at home" parking of the van, preferably in a locked garage.

7. Keep a record, satisfactory to Chrysler, of the operation, expense and income of the van.

Chrysler agrees to reimburse the Driver/Coordinator for his out-of-pocket expenses in the operation of the van to and from work along the prescribed route and to pay over to the Driver/Coordinator 50% of any fares received from passengers in excess of the required minimum of nine (9). Chrysler will report to appropriate taxing authorities any amounts paid to the Driver/Coordinator for passengers in excess of nine (9), and it will be the responsibility of the Driver/Coordinator to include such amounts on his individual tax returns.

The Driver/Coordinator will be permitted to use the van during off hours. Chrysler also agrees that the Driver/Coordinator may, as an inducement to the person who agrees (as provided below) to serve as back-up driver, make the vehicle available for use by the back-up driver at the same rate and under the same terms as applicable to the Driver/Coordinator, as set forth herein. The back-up driver also must maintain the required state driver's license for operating a van, and loss of his license will result in his automatic removal as back-up driver.

Chrysler reserves the sole right to decide if the off-hour use of the vehicle is proper and does not become excessive as to type of use or mileage.

It is agreed that the following regulations apply to the operation of the van:

1. Operation of the unit is permitted only by the Driver/Coordinator and back-up driver and by the spouse of either of them, if properly licensed. Only under emergency conditions will any other person be permitted to operate the vehicle. In this connection, in the absence of both the Driver/Coordinator and the back-up driver, any Chrysler employee that is a member of the van pool may operate the van for pickup and delivery of passengers to and from work if he is authorized to do so by the Driver/Coordinator and is properly licensed.

2. The vehicle is to carry no passengers to and from Chrysler facilities, other than Chrysler employees.

3. In the case of personal use, the carrying of passengers other than Chrysler employees and members of the immediate household of either the Driver/Coordinator or the back-up driver is permissible as long as it is not on a regular basis.

4. The vehicle is not to be used for a trip beyond a one-hundred (100) mile radius of the Driver/Coordinator's home without specific advance written approval from Chrysler.

5. The vehicle is not to be used to carry passengers or freight for hire, for ride sharing or any other purpose involving pay for transportation, other than the specific purpose of the Chrysler Commuter Van Program.

6. Use of the vehicle to pull trailers is not allowed. No trailer hitches, temporary or permanent, are to be attached to the unit.

7. The vehicle is to be driven only on hard surfaced public streets and highways and other normal access roads and driveways, and is not to be driven off normal roads, on frozen lakes and rivers, or in any other manner that would expose the vehicle to unsafe conditions.

8. The vehicle is not to be driven over bridges posted for a maximum weight of 3 tons or less.

9. The Driver/Coordinator is responsible for promptly reporting any accident involving bodily injury or property damage. Such reporting is to be in accordance with the procedures outlined in the Auto Accident Information Kit, which is to be in the glove compartment of the unit at all times.

   a. Such reporting is also to include injury to a passenger in the van even though no other party is involved. (This would include such cases as a person falling inside the vehicle or injuring himself while entering or alighting from the vehicle.)

   b. The Driver/Coordinator will be responsible for completing and filing the appropriate state motor vehicle bureau accident report as well as the Chrysler automobile accident report (Form _____).

10. Any traffic violation involving the van are the responsibility of the driver. The Driver/Coordinator and back-up driver are to report promptly any traffic violations to Chrysler.

This Agreement may be terminated by either party on thirty (30) days written notice delivered to the other party in person, by telegram or by mail. In addition, it will terminate automatically on (a) termination of the Driver/Coordinator's employment with Chrysler, (b) loss by the Driver/Coordinator of the required state driver's license or (c) breach by the Driver/Coordinator of the terms of this Agreement.

_____
Driver/Coordinator

Accepted:

Chrysler Corporation

By _____

Date _____

## Agreement to Serve as Back-up Driver

I have received a copy of the above Operating Agreement, have read it and agree to be bound by its terms in serving as back-up driver to the above Driver/Coordinator. I understand that breach of such terms will result in automatic termination of my right to serve as back-up driver.

| | Signature | Commencement Date | Termination Date |
|---|---|---|---|
| 1. | _____ | _____ | _____ |
| 2. | _____ | _____ | _____ |
| 3. | _____ | _____ | _____ |
| 4. | _____ | _____ | _____ |

## APPENDIX II A Typical Fare Calculation

**Depreciation Cost**

| | |
|---|---|
| Depreciation per month for 40-mile round trip | $ 133.00 |
| **Insurance Cost** | 105.00 |

**Administration Cost**

| | |
|---|---|
| Costs incurred by Commuter Transportation Services, Inc. for administration of Van pool Program | 25.00 |
| Monthly fixed costs (based on 40 miles) | $263.00 |

**Operating Costs ($ per mile)**

| | | |
|---|---|---|
| Gasoline | $ | 0.10 |
| Lube, minor maintenance | $ | 0.02 |
| Tires, brakes, battery | $ | 0.01 |
| Miscellaneous | $ | 0.01 |
| Total Operating Cost | $ | 0.14 |

Total monthly operating cost is determined by the number of miles involved × 260 working days × 14¢ per mile divided by 12 months = monthly operating costs.

| | |
|---|---|
| Operating costs for a 40 mile round trip | $ 121.00 |

**Individual Fare**

| | |
|---|---|
| Individual fare is determined by dividing the total monthly cost of the vehicle by eight (the number of passengers in each vehicle) | $ 48.00 |

## Tips on saving energy and money through efficient people moving

### Organizing a Carpool Program

1. Appoint a committee to head implementation of the project.
2. Determine the details on how the program will be administered, and what incentives and/or disincentives, if any, will be adopted.
3. Motivate employees using one or more of the following procedures: Conduct information meetings with time set aside to answer questions, distribute circulars, attach brochures with paycheques, post information on bulletin boards, etc. All publicity should mention incentive program if one exists.
4. Distribute application forms. Application form should provide a place where employee can indicate whether he/she wishes to be a driver/passenger or just a passenger. To ensure employee does not "forget" to fill in the form, the form should state that it is to be returned to his/her immediate supervisor by a specified date, regardles of whether he/she wishes to participate.

5. Collect application forms.
6. Match manually or by computer. (Note, the Federal Government has a computer matching program soon to be available on request.) In cases where employees work different shifts, investigate the use of a pegboard to accommodate the need for more flexible carpooling systems.
7. Notify employees re pool they are in. Allow for some flexibility, if an employee wishes to be in another pool.
8. Maintain the program by periodically updating master lists and informing any new employees about the program.

**Organizing a Vanpool program**

1. Appoint a committee to head implementation of the project.
2. Determine
   a) whether vans will be purchased or leased.
   b) type of insurance required
   c) legalities
   d) fare calculation procedures
   e) fare collection procedures
   f) driver arrangements
   g) rules for vanpool participants
   h) whether there will be an incentive program, and if so what incentives will be offered.
3. Advise union officials, or employee representatives of your company's intentions.
4. As vanpools are a relatively unknown concept in Canada, employees must be fully briefed about how the concept works before any meaningful employee survey can be conducted. Meetings should be held not only to explain the concept but also to explain the advantages to employer, employees, and greater community. If incentives program should be mentioned, if one exists.
5. In addition to the meeting, one or more of the techniques described in carpool procedure #3 may be used.
6. Distribute application forms. Application forms should provide a place where the employee can indicate whether he/she wishes to be a driver/co-ordinator or just a passenger. To ensure the employee does not forget to fill in the form, the form should state that it is to be returned to his/her immediate supervisor by a specified date, regardless of whether he/she wishes to participate.
7. Collect application forms, and compile lists of riders and prospective driver/co-ordinators.
8. Match manually or by computer — see carpool procedure #6.
9. Contact and evaluate prospective driver/co-ordinators.
10. Select driver/co-ordinators, and provide each with a list of participants in his/her pool.
11. Calculate participant fares for each pool and brief driver/co-ordinators on fare collection procedures.
12. Sign agreements with driver/co-ordinators.
13. Sign agreements with pool riders.
14. Purchase or lease vehicles and arrange for delivery to driver/co-ordinators.
15. Maintain the program — see carpool procedure #8.

**Incentives and Disincentives Suggestions**

1. Establish priority parking for carpool and vanpool vehicles.
2. Provide free or reduced parking fees for pool participants, and/or raise the rates for low occupancy vehicles.
3. Give automobile operating cost incentives to carpoolers.
4. Provide working hour incentives for carpoolers—slightly reduced working hours, shift rotation preferences, flexible working hours or encouragement of maintenance of normal working hours so that carpoolers will not be subject to overtime and can meet their pools.

**Checking the legalities**

1. Check with outside agencies and company lawyers to make sure of the legalities of such things as drivers licences, taxi regulations, exclusive franchise rights of transit systems, insurance, employer liability and personal liability.

# SI USAGE

## Derived SI Units Having Special Names

| Quantity | Unit | Formula | Symbol |
|---|---|---|---|
| Frequency | hertz | $s^{-1}$ | Hz |
| Force | newton | $kg{\cdot}m/s^2$ | N |
| Pressure or Stress | pascal | $N/m^2$ | Pa |
| Energy or Work | joule | $N{\cdot}m$ | J |
| Power | watt | J/s | W |
| Electric charge | coulomb | $A{\cdot}s$ | C |
| Electric potential | volt | W/A | V |
| Electric resistance | ohm | V/A | Ω |
| Electric conductance | siemens | A/V | S |
| Electric capacitance | farad | C/V | F |
| Magnetic flux | weber | $V{\cdot}s$ | Wb |
| Magnetic flux density | tesla | $Wb/m^2$ | T |
| Inductance | henry | Wb/A | H |
| Luminous flux | lumen | $cd{\cdot}sr$ | lm |
| Illuminance | lux | $lm/m^2$ | lx |

## Common Equivalents and Conversions

| Approximate Common Equivalents |
|---|
| 1 in. = 25 mm |
| 1 ft. = 0.30 m |
| 1 yard = 0.91 m |
| 1 mile = 1.6 km |
| 1 sq. in. = 6.5 $cm^2$ |
| 1 sq. ft. = 0.09 $m^2$ |
| 1 sq. yd. = 0.84 $m^2$ |
| 1 acre = 0.40 ha |
| 1 cu. in. = 16 $cm^3$ |
| 1 cu. ft. = 28 $dm^3$ |
| 1 cu. yd. = 0.76 $m^3$ |
| 1 quart (liq) = 1.1 ℓ |
| 1 gallon = 4.5 ℓ |
| 1 oz. (Avdp.) = 28 g |
| 1 lb. (Avdp.) = 0.45 kg |
| 1 hp (UK) = 0.746 kW |
| 1 lbf. = 4.4 N |
| 1 psi = 6.9 kPa |

## Some Other Derived SI Units

| Quantity | Unit | Symbol |
|---|---|---|
| Area | square metre | $m^2$ |
| Volume | cubic metre | $m^3$ |
| Velocity-angular | radian per second | rad/s |
| Velocity-linear | metre per second | m/s |
| Acceleration-angular | radian per second squared | $rad/s^2$ |
| Acceleration-linear | metre per second squared | $m/s^2$ |
| Density (mass per unit volume) | kilogram per cubic metre | $kg/m^3$ |
| Moment of force | newton metre | $N{\cdot}m$ |
| Viscosity-dynamic | pascal second | $Pa{\cdot}s$ |
| Thermal conductivity | watt per metre kelvin | $W/(m{\cdot}K)$ |
| Thermal flux density, Irradiance | watt per square metre | $W/m^2$ |
| Thermal capacity or Entropy | joule per kelvin | J/K |
| Permeability | henry per metre | H/m |
| Permittivity | farad per metre | F/m |
| Thermal resistance (R value) | square metre kelvin per watt | $m^2K/w$ |
| Energy density | joule per cubic metre | $J/m^3$ |

## SI PREFIXES

| Multiplying Factor | Prefix | Symbol |
|---|---|---|
| 1 000 000 000 000 000 000 = $10^{18}$ | exa | E |
| 1 000 000 000 000 000 = $10^{15}$ | peta | P |
| 1 000 000 000 000 = $10^{12}$ | tera | T |
| 1 000 000 000 = $10^{9}$ | giga | G |
| 1 000 000 = $10^{6}$ | mega | M |
| 1 000 = $10^{3}$ | kilo | k |
| 100 = $10^{2}$ | hecto | h |
| 10 = $10^{1}$ | deca | da |
| 0.1 = $10^{-1}$ | deci | d |
| 0.01 = $10^{-2}$ | centi | c |
| 0.001 = $10^{-3}$ | milli | m |
| 0.000 001 = $10^{-6}$ | micro | μ |
| 0.000 000 001 = $10^{-9}$ | nano | n |
| 0.000 000 000 001 = $10^{-12}$ | pico | p |
| 0.000 000 000 000 001 = $10^{-15}$ | femto | f |
| 0.000 000 000 000 000 001 = $10^{-18}$ | atto | a |

## Some Non-SI Units Used with the SI

| Unit | Symbol | Value in SI Units |
|---|---|---|
| minute | min | 1 min = 60 s |
| hour | h | 1 h = 3600 s |
| day | d | 1 d = 86 400 s |
| degree (of arc) | ° | $1\,^{\circ} = (\pi/180)$ rad |
| minute (of arc) | ′ | $1\,' = (\pi/10\,800)$ rad |
| second (of arc) | ″ | $1\,'' = (\pi/648\,000)$ rad |
| litre | l or ℓ | 1 ℓ = 1 $dm^3$ = $10^{-3}$ $m^3$ |
| tonne | t | 1 t = $10^3$ kg = 1000 kg |
| hectare | ha | 1 ha = 10 000 $m^2$ |

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